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OF THE

PATHOLOGICAL SOCIETY

OF

PHILADELPHIA

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Parasitic Hemoptysis Due to Paragonimus Westermanii.[1]

CH. WARDELL STILES, PH.D.,
ZOOLOGIST U. S. BUREAU OF ANIMAL INDUSTRY,
WASHINGTON, D. C.

MR. PRESIDENT AND GENTLEMEN: It is with great pleasure that I respond to your kind invitation to discuss before you this evening the subject of parasitic hemoptysis, and to exhibit specimens of the parasite and the lesions it produces. My remarks will practically be an abstract of a paper[2] on the subject which will shortly appear in one of the publications of the U. S. Department of Agriculture.

A number of specimens of lung flukes taken from hogs in February have been forwarded to the Zoological Laboratory by Dr. A. J. Payne, Bureau of Animal Industry, inspector in charge at Cincinnati, Ohio.

As nearly as can be determined at present, the worm is specifically identical with the lung fluke known under the various

[1] Read by invitation, November 14, 1900.

[2] Ch. Wardell Stiles and Albert Hassall, Notes on Parasites, 51: The Lung Fluke (*Paragonimus Westermanii*) in Swine and Its Relation to Parasitic Hemoptysis in Man; XVI. Annual Report of the Bureau of Animal Industry (for 1899), 1900, pp. 560–611.

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names of *Distoma pulmonale*, *D. Ringeri*, and *D. Westermanii*, for which Braun has recently erected a new genus *Paragonimus*. *Paragonimus Westermanii* (this being the correct binomial for the worm) was originally described by Kerbert, in 1878, from the lungs of a tiger which died in Amsterdam. A similar parasite was afterward found in man in Japan by Baelz and in Formosa by Ringer, and, though originally supposed to represent a new species, it is now generally admitted to be identical with Kerbert's form from the tiger. Ralliet (1890) afterward reported the same parasite from the dog in Japan, having examined some specimens in the Japanese department of the Paris Exposition of 1889; Ward (1894) reported it for the cat in the United States, and later (1895) he determined, as identical with this species, certain undetermined distomes which Kellicott (1894) had reported from a dog in Ohio. The present article is the first in which this lung fluke is recorded for hogs.

Referring to its systematic position, this parasite has always been placed in the family Fasciolidæ. Originally it was placed in the collective genus *Distoma*. Later it was transferred to *Mesogonimus*, which latter name was afterward suppressed in favor of *Clinostomum*. Blanchard (1891) recognized that the species in question was scarcely congeneric with the other members of the genus *Mesogonimus*, while Stiles and Hassall (1898) and MacCallum (1899) indicated its disagreement with the type species of *Clinostomum*, and intimated that this genus should be divided. Braun (1899) proposed for *D. Westermanii* the new genus *Paragonimus*, where it should now be placed.

The generic synonymy and diagnosis stand as follows:

Genus PARAGONIMUS Braun, 1899.

1899, December 11: *Paragonimus* BRAUN, 1899. Type, *Distoma Westermanii* Kerbert, 1878.

1899, December 30: *Polysarcus*[1] LOOSS, 1899. Type, *Distoma Westermanii* Kerbert, 1878.

GENERIC DIAGNOSIS. Fasciolidæ: Body medium large, thick, elongate, frequently oval, and on transverse section more or less round, usually somewhat

[1] Note: *Polysarcus* Fieb., 1853, orthopteron; *Polysarcus* Sauss., 1859, orthopteron; *Polysarcus* Lef., coleopteron; *Polysarca* Schin., 1866, dipteron.

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attenuate toward posterior extremity. Cuticle provided with scale-like spines. Intestine with strong, somewhat elongate pharynx; very short esophagus; intestinal ceca zigzag, extending to caudal end of the body. Median excretory stem (or bladder), large dorsoventrally, irregular in outline, and extending cephalad to near the pharynx. Genital pore near caudal margin of ventral acetabulum, in median line or to the right or left. Copulatory organs (cirrus) absent. Testicles[1] round (?) or branched in posterior half of body, one each side of median line and one slightly posterior to the other. Ovary somewhat branched, the branches being thick and short, and the organ located posterolateral of the ventral acetabulum, on the right side (right or left side) of the median line opposite to the main portion of the uterus. Receptaculum seminis absent; Laurer's canal present. Vitellaria enormously developed, extending from anterior to posterior end of the body and located (as seen in cross section) on the periphery, usually leaving a longitudinal free space both in the dorsal and ventral median field. The transverse vitelloducts pass cephalad of the testicles, but caudad of ovary and uterus. Uterus may be only slightly developed or may form a comparatively large-sized roset, more than half as broad as the body. It may be located entirely on one side (right or left) of median line or may extend both sides of median line, partially covering the ovary. Eggs rather large, about 80 to 118 μ long by 48 to 60 μ broad. Embryo develops after oviposition.

HABITAT. Encysted, usually two in each capsule, in lungs of mammals.

TYPE SPECIES. *Paragonimus Westermanii* (Kerbert, 1878).

Leuckart compared Kerbert's specimens of *Distoma Westermanii* from the tiger with specimens of *D. pulmonale* from man, and gave the positive assurance that they were specifically identical, an opinion in which Nakahama concurred. So far as we are aware no actual comparison of the Japanese specimens from the dog with specimens from man has yet been made by any zoologist. Likewise no actual comparison of any of the American specimens from the dog, cat, or hog has as yet been made with any Asiatic specimens from man, tiger, or dog; but neither Ward nor we have felt justified, so far as we could judge from descriptions, in maintaining that the American lung fluke is specifically distinct from the Asiatic worm.

Even if it should eventually be shown that the American specimens are distinct from the Asiatic, still, in case the form found in dogs in Japan is actually identical with the form found there in man, there is reason to assume that the species found in the dog by Kellicott will also be able to develop in man. That man may

[1] Cobbold's figure of *P. compactus*.

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harbor the same parasite as cats and dogs is supported by the fact that this particular worm is reported in Japan both for man and dogs, as well as by the fact that certain feline and canine parasites are also parasitic in man (*Coccidium bigeminum*, *Ascaris*, *Dipylidium*).

PARAGONIMUS WESTERMANII (KERBERT, 1878), STILES AND HASSALL, 1900.

SPECIFIC DIAGNOSIS. *Paragonimus:* 8 to 16 mm. (after Kellicott, 15 to 20 mm.) long, 4 to 8 mm. broad, 2 to 5 mm. thick; plump, pinkish to reddish-brown (alive) or slate (preserved) in color; live specimens are depressed and with variable outline; preserved specimens often oval to elongate pyriform, transverse section round or nearly so, anterior end bluntly rounded, posterior end less blunt. Oral sucker 0.53 to nearly 0.75 mm. (Leuckart) or more (0.864 by 1.017 mm. or 1 to 1.4 mm.[1]—Ward); or 0.80 to 1.12 by 0.80 to 0.83 mm. (Stiles and Hassall); 0.78 (Kerbert) in diameter, terminal or subterminal in different specimens from the same lung. Ventral acetabulum (0.6 to at most 0.75 mm.—Leuckart; 0.78 mm.—Kerbert; 0.75 to 1.017 mm.—Ward; 0.88 to 1.2 by 0.86 to 1.44 mm.—Stiles and Hassall) very slightly larger than oral sucker; situated somewhat anterior to middle of the body, 2 to 4 mm. back of oral sucker. Cuticle provided with broad scale-like spines.[2] Genital pore, often indistinct, closed to the caudal margin of ventral acetabulum, may be in the median line or immediately to the right or left of it.[3] Pharynx elongate; esophagus very short, so that the bifurcation of the intestine is considerably anterior to the ventral acetabulum; intestinal ceca usually somewhat zigzag, some distance from each other, run irregularly to posterior extremity. *Male organs:* Cirrus and cirrus pouch absent; ductus ejaculatorius straight; testicles tubular, ramified, one slightly posterior to other, on each side of median line. *Female organs:* Ovary branched, lateral, right or left of median line, somewhat posterior to acetabulum and anteroventral of transverse vitelloduct; on the opposite side of median line, at about the same height, is situated a lobate shell-gland and a rather short, massed uterus; in some specimens the latter may spread across the median line and partially cover the ovary; folds of uterus extend ventrally of shell-gland; vitellogene glands marginal, highly developed, extending from anterior to posterior extremity, often leaving but a small portion of the dorsal and ventral median field uncovered; transverse vitelloducts dorsal; vitelline reservoir large; Laurer's canal present. Eggs oval, 80 to 100 μ long by 56 μ broad (Leuckart); 96 to 118 μ long by 48 to 53 μ broad (Ward); 68 to 96 μ long by 48 to 60 μ broad (S. and H.); yellow shell. Mira-

[1] Suckers distorted, measurements not exact.—WARD.

[2] Largest in middle of the body, after Leuckart, but largest on anterior portion, after Kerbert; smallest around mouth, after Stiles and Hassall.

[3] The character attributed to this species relative to the situation of the genital pore on the left of the lateral line would appear to be somewhat diagrammatic; we have found it median, right or left, in specimens from hogs, and Kerbert reports it median.

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cidium ciliated, develops after eggs leave the host. Sporocyst, redia, cercaria, and intermediate host not known.

HOSTS. Royal tiger (*Felis tigris*); cat (*Felis domestica*); dog (*Canis familiaris*); hog (*Sus scrofa domestica*); man (*Homo sapiens*).

LIFE HISTORY. The complete life cycle of the lung fluke has not yet been experimentally demonstrated. According to our present knowledge, the egg does not develop until it leaves the host in the sputum.

Segmentation. Pending confirmation of the alleged early segmentation of the egg before it is laid (Kerbert) or in the sputum (Manson), or of its possible development to the miracidium stage in the tissues of its host (Kellicott), it is more natural for us to expect, especially in view of Leuckart's observations, that the normal course of events is for the egg to be laid in unsegmented stage and to be expectorated in that condition. This is certainly what occurs in the form found in hogs. As yet no literature is accessible giving an account of how the segmentation of this species takes place.

Miracidium (ciliated embryo). Thus far at least two observers (Manson, 1882, and Nakahama, 1883) have succeeded in raising the embryonic stage. Manson (1882) states that when the eggs are washed free from the sputum and kept in water at a temperature of 80° to 94° F. (26.7° to 34.4° C.) an embryo develops in about six weeks to two months. This miracidium is ciliated only on the posterior two-thirds of its body, the cilia "extending as far forward as the rounding in of the shoulders." Nakahama's paper is in Japanese, and we are unable to read it, but according to Leuckart (1889) Nakahama succeeded in showing that when the eggs which are expectorated in the sputum are subjected to a temperature of 30° C. (86° F.) for twenty-eight days the ciliated embryo is developed. This miracidium is oval in form and is provided with a small projection on its anterior extremity. According to Manson, if expressed from the eggshells a week or two after the cilia develop, the embryos live in water only a few minutes, but at a later stage, when the miracidium escapes from the egg by its own efforts, it may live much longer. Manson kept one alive over twenty-four hours. From certain experiments detailed in his

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article, Manson concludes that upon expectoration from the lungs the eggs perish unless they are freed from the surrounding mucus and have access to water; if, however, water is supplied to them even in small amount, they preserve their vitality. Thus it would appear that in water freed from the mucus and exposed to a temperature of 80° to 94° F. (26.7° to 34.4° C.) the ciliated embryo develops in from four to eight weeks, and that certain conditions, such as not being freed from mucus and probably a lower temperature, retard the development.

How long the eggs preserve their vitality in dried sputum or in dust does not appear to have been established. From a hygienic stand-point definite information on this point is important. Remaining in moist sputum for any length of time, corresponding to a part of Manson's experiments, would probably rarely occur in nature.

Beyond the miracidium stage nothing is positively demonstrated in the development of *Paragonimus Westermanii*. As Leuckart remarks, it would be contrary to all analogy to assume that this is the infecting stage for man and other animals. On the contrary, the presence of cilia indicates an aquatic life, and, so far as can be foreseen from analogy, the miracidium, after swimming around in water, will eventually attack some invertebrate (probably a mollusk) and will develop into a sporocyst; rediæ and cercariæ will probably be formed, much the same as are described for *Fasciola hepatica*, and either an encysted or free-swimming cercaria will in all probability be the stage in which the parasite will enter its final host (man, cat, tiger, dog, hog).

Whether it will immediately attack the lungs, as suggested by Baelz, or first some other organ and later wander to the lungs, as suggested by Leuckart (1889), is an open question. In this connection reference may be made to the finding of an agamic distome in hogs' muscles by Mr. Bullard, at Buffalo, N. Y. It cannot at present be considered impossible that Bullard's parasites represent a younger stage of the lung fluke, either accidentally or normally encysted in the muscular tissue.

Source of Infection. The discussion of the life history and the assumption that a cercaria forms the infecting stage bring up several views expressed in Japan. Throughout the Asiatic liter-

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ature on the subject frequent references are made to the water-supply, and it is clear that our Eastern colleagues look upon this as the source of infection. This view has much in its favor, and cautious persons will do well to drink only boiled or filtered water, especially when in infected fluke areas. The following references by various writers will be of interest in this connection. Manson (1882) in referring to one of his patients (Heng) writes:

> He says he never exercised discretion about the water he drank, especially when young; used to take it from the river, well, paddy field, or ditch—whichever lay most convenient; and he says that nearly all North Formosans are similarly indiscreet.

As prophylactic measures, Kiyono, Suga, and Yamagata (1881) advise against eating "raw eggs, uncooked fish, mussels," etc. Dr. Inoui and Yamagiwa (1890) state that in Okayama, where they studied a number of cases, a species of snail belonging to the genus *Limnæus*, and known as "Nina," is very abundant. Although they examined large numbers of these mollusks, they did not find any cercariæ, rediæ, or embryos of the lung fluke. Similar negative results attended their dissection of small fish. The peasants eat both snails and fish, but usually cooked. The inhabitants of the villages say that chickens suffer from a cough similar to that noticed in this malady, and that they eat the sputa of persons suffering from lung-fluke disease. On this account Inoui and Yamagiwa examined both chickens and eggs anatomically and microscopically, but without finding any trace of infection. As a prophylactic measure, Yamagiwa in a later article (1892) also advises against eating raw meat.

That chickens eat human sputa is a well-known fact, but the possibility of their becoming infected with lung flukes through sputum from lung-fluke patients may safely be looked upon as excluded. It seems possible that the cough referred to may be connected with the chicken disease known as "gapes," caused by *Syngamus trachealis* in the windpipe; while it seems more than probable that hens' eggs have fallen under suspicion because of the occasional presence of a fluke which, to the casual observer, is not entirely unlike the lung fluke; it belongs to the species *Prosthogonimus ovatus* and has nothing to do with *Paragonimus Westermanii*. As for not eating raw meat, the advice is good on

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general principles, but it does not at present appear that such food will come into consideration as a probable source of infection. That Bullard's agamic distome in the muscles of hogs is the infecting stage of *P. Westermanii* may be admitted as among the remote possibilities, but hardly more. Very little pork is eaten in Northern Japan, and, while eaten more in Southern Japan, it is not a common article of diet among the poorer classes. This fact, and also the fact that the parasite is so much more common in men than in women, rather detract still more from the probability of such a source of infection. Should the unexpected prove to be the case, and Bullard's encysted form actually represent the long-looked for stage of *P. Westermanii*, ordinary curing or cooking will undoubtedly prevent all danger of infection. Of all possible sources of infection thus far suggested, the water-supply and the mollusks would appear to be more natural carriers of the cercarian stage than anything else. The lion, cat, dog, hog, and man—all of the animals for which this lung fluke[1] has been reported—are in the habit of eating meat, but all of them also drink water.

Since *Paragonimus Westermanii* has now been found in so many cases in hogs in the United States, it would indeed be strange if man had entirely escaped infection. In fact it seems quite probable that cases of parasitic hemoptysis have actually occurred in man in this country, but have remained unrecognized. We would naturally expect the first cases to appear in rural districts, and since the country practitioner does not, as a rule, use the microscope in diagnosis, such cases would naturally be mistaken for tuberculosis.

From a practical stand-point, not only because the parasite has already been found in America, in three different species of domesticated animals, but also because some of our troops returning from Asia may further import this disease with them, it appears advisable to bring the chief features of the malady to the general attention of practitioners as soon as possible. This must be done through the government reports, medical societies, and medical journals, as the disease is not discussed in American works on practice.

[1] *Herpestes*, the host of *Paragonimus compactus*, and *Lutra*, the host of *P. rudis*, are also carnivorous.

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THE LUNG FLUKE IN MAN (*Homo sapiens*) AS CAUSE OF PARASITIC HEMOPTYSIS AND JACKSONIAN (CORTICAL) EPILEPSY.

NAME OF THE DISEASE. The disease now under discussion is known under the following names:

ENGLISH.—*Parasitical hemoptysis* Manson, 1880, and *The Lancet*, 1880, *Endemic hemoptysis* Manson, 1883; *Lung-fluke disease* (as vernacular term); Pulmonary distomatosis (in part).

GERMAN.—*Parasitäre Haemoptoë* Baelz, 1880; *Wurm-Haemoptoe* Leuckart, 1889; *Lungendistomen-Krankheit* Yamagiwa, 1892.

FRENCH.—*Hémoptysie parasitaire* Chédan, 1886; *Distomatose pulmonaire* Blanchard, 1895.

ITALIAN.—*Emottisi parassitica* Sonsino, 1884; *Emottisi cronica* Sonsino, 1896.

SPANISH.—*Hemoptysis parasitaria* Bonis & Cortezo, 1882.

LATIN.—*Gregarinosis pulmonis* Bonis & Cortezo, 1882; *Distomatosis pulmonum; Gregarinosis pulmonum* Baelz, 1880.

The presence of lung flukes in man causes various symptoms, according to the location of the parasites. The two chief clinical forms in which the malady appears are the so-called parasitic hemoptysis and parasitic hemoptysis in connection with Jacksonian (cortical) epilepsy.

GEOGRAPHIC DISTRIBUTION OF THE DISEASE. Lung-fluke disease has been reported for the following places:

Japan. Hon-shu Island, from northeast (provinces of Awomori, Sendai, Izu, Shinano, and Gifu) to southwest (provinces of Okayama, Shimane, and Yamaguchi); also on the Kiushu Islands (provinces of Kumamoto, Nagasaki, and Kagoshima).

China. North Formosa especially, and Manson believes the large number of cases of hemoptysis he formerly noticed in central and southern Formosa are of the same nature.

Korea. Case of a Korean royal prince.

FREQUENCY. In a number of articles the statement is found that in certain parts of Formosa 15 per cent. of the inhabitants are affected. This statement is in at least one article attributed to physicians, but it appears to be due to an estimate made by a servant. Manson (1882) says, in referring to two Chinese patients:

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Regarding their acquaintances, one of them said that 20 or 30 per cent. and the other that 15 per cent. spat blood. Possibly these are overestimates, but at all events they show that the disease is extremely prevalent.

Baelz, in a letter to Leuckart (1889), states that he knows of one village in Japan in which nearly all the inhabitants harbor lung worms. Taylor (1883) thinks it too early to make statements regarding the frequency of the malady, for the disease is usually mistaken for tuberculosis, since it can be diagnosed only with the aid of the microscope (not much used by Japanese physicians at that date), and since only a portion of the cases come to the notice of physicians. Blanchard (1895) states that in the provinces of Okayama and Kumamoto, both mountainous, the disease is so frequent in certain villages and so dreaded that the inhabitants of neighboring villages will have no relations with them, and even the physicians do not wish to go there because of fear of infection. (The origin of this statement has escaped us. See, however, Railliet, 1893.)

PREDISPOSITION. According to Yamagiwa (1892, p. 454), certain persons are more predisposed to the disease than others. From a helminthologic stand-point it may be questioned whether the fact that the disease has been found more in certain classes of patients than in others is due to an actual predisposition or whether it is not due rather to a greater risk of infection to which some persons may be subject. Thus tapeworms appear to be more common in women than in men; but this fact is due to women being more liable to infection (in preparing food) rather than to any constitutional predisposition. The various data gathered thus far are as follows:

Age. While the disease may attack persons of any age, it appears to be rarely diagnosed in very young or very old persons. From present statistics it is more common in persons in youth and early manhood. Thus of 59 cases compiled from literature, 45 were from patients between 11 and 30 years old.

Sex. Judging from statements by Eastern authors and from accessible statistics, the disease is more frequently diagnosed in male than in female patients, and it may therefore be assumed that men are more exposed to infection than women. Thus of

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66 compiled cases of known sex, 58 were males and 8 were females.

Occupation. Taylor (1883) says that the parasite attacks persons irrespective of occupation. He is undoubtedly correct in this intimation that occupation is no protection against infection if the person is exposed. Yet there need be no surprise if, as is to be expected, persons following certain occupations will be more subject to infection than persons otherwise employed. From the few statistics thus far collected relative to occupation, it may be noted that of 51 patients 38 were farmers, 6 officials, 1 student, 1 laborer, 1 merchant, 1 coolie, 1 house boy, 1 shoemaker, 1 prince. Yamagiwa (1892) states that in Kumamoto students (hospital cases) are among the most frequently affected.

Personal habits. Yamagiwa (1892) records that 12 patients out of 38 were drinkers.

Physical condition. Several authors state that persons of strong constitution are more subject to the disease than persons of weak constitution.

DURATION. It is generally conceded that patients may live for years—ten to twenty, or perhaps more—after noticing the first symptoms.

PROGNOSIS. Patients may entirely recover if sent into a healthy noninfected area. Yamagiwa has repeatedly noticed cases of this kind where egg cysts were found in the mesentery, mediastinum, or lungs, but no adult worm was found. In general the prognosis depends upon (*a*) the number and (*b*) position of the parasites present, (*c*) age of patient, and (*d*) complications.

(*a*) The greater the number of parasites in the lungs the greater is the chance of severe pulmonary hemorrhage or of emboli in the brain.

(*b*) If the worms are confined to the lungs the patient may live for years. Severe hemorrhage or repeated profuse hemorrhages are naturally dangerous in proportion to the amount of blood lost within a given time. If the parasites or their eggs gain access to the brain, the prognosis is unfavorable.

(*c*) According to Yamagiwa (1892) development of patients under ten years of age is retarded by lung-worm infection, while in old patients the nourishment is considerably impaired.

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(*d*) When complicated with pulmonary tuberculosis, prognosis is unfavorable.

DIAGNOSIS. Microscopic examination of sputa for *Paragonimus* eggs.

TREATMENT. Manson (1882) tried several treatments by inhalations, and thought they were not entirely unsuccessful. Taylor (1883) has no confidence in specific treatment, but advises a general course of medication, according to indication. Yamagiwa (1892) knows of no practical specific medical treatment. He thinks surgery might be tried if the exact position of the more superficial cysts could be more definitely located (X-rays?). By change to an uninfected region danger of reinfection is avoided and the parasites may disappear, becoming disintegrated, or, in some cases, possibly by being coughed up.

PROPHYLAXIS. Positive prophylactic measures cannot be given until the cercaria stage of the parasite is found. In general, however, care regarding the drinking water—to have it filtered or boiled—appears to be the most probable preventive measure which can now be proposed. There appear to be no valid grounds at present for suspecting eggs, fish, or meat, as suggested by some of our Japanese colleagues.

The following measures would undoubtedly accomplish much in preventing the disease from spreading:

(*a*) Infected patients should use sputum boxes, such as are used by consumptives. If cuspidors are used, it would be positively dangerous to empty their contents into any drain the sewage of which does not go directly into the sea. In all probability salt water would kill the miracidium. To empty cuspidors into a drain the sewage of which is used for fertilizing would be deliberately to comply with conditions which would be, on general principles, most favorable to the spread of the disease. If the sewage drains into a river the conditions for spreading the disease would also be very favorable. A comparison of the relative merits of the dry *versus* the wet cuspidor cannot be given until experiments in drying the eggs are conducted. On general principles the dry cuspidor would be better in this case (contrary to the conditions in tuberculosis), since, as a rule, trematode eggs are easily killed by drying.

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(*b*) Cats and dogs which cough up blood should be examined for this parasite, and if *Paragonimus* eggs are found in the expectorations the animals should be killed and burned.

(*c*) If hogs are discovered coughing up a dirty yellow, brown, or bloody expectoration they should immediately be sent to slaughter. In abattoir inspection infected portions should be "tanked for fertilizer," but if healthy the meat of such a hog may be safely placed on the market. (See Abattoir Inspection.)

SYMPTOMS. The symptoms vary according to the location of the parasite.

(*a*) *Lung infection.* This is the usual form. Sputa very similar to that seen in pneumonia, and of a dirty red to brown color, due to the presence of microscopic worm eggs; spitting of blood common, but not constant, often intermittent; cough common, but not constant. All symptoms increased after violent exertion. *The only constant and specific characteristic is the presence of the eggs in the sputum; as many as* 12,000 *eggs may be expectorated daily.*

Manson (1882) gives the following as a typical case:

Heng, male, aged thirty-one years; resides in Singhang, Tamsui, where he works as a house coolie. His family, he says, is quite healthy; his mother, aged forty-four years, and three brothers and four sisters, are alive and well. His father died at fifty-eight years of dropsy, and a sister died in childhood of smallpox. He himself is liable to ague. He was born in the town of Banka and lived there till his eighteenth year; then he lived in Kelung for two or three years; afterward he removed to Hobe, Tamsui, where his home has been for the last ten years. He has travelled about the north part of the island a good deal; been in Tekchham two or three years ago, and eight months ago accompanied some Japanese to Khilai, on the east coast, where he resided for upward of a month. His blood-spitting dates from eleven years ago; he was then working on the tea hills with his father near Banka. At first he noticed, when he breathed hard in carrying heavy burdens, that he coughed a little and brought up mucus mixed with blood; but, as a rule, unless exerting himself violently, he brings up only a few drops mixed with the mucus. Sometimes he does not spit for a few days, and then the hemoptysis recurs, to last for one or two months. He has a slight cough, but on auscultation nothing much amiss can be detected. His thorax is finely developed.

Lung infection may be complicated by infection of the (*b*) brain, (*c*) liver, or (*d*) other organs.

(*b*) *Brain infection.* If the worms or their eggs gain access to

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the brain, epileptiform attacks (Jacksonian or cortical epilepsy) may result. Cases have been reported by Otani (1887), Inoui and Yamagiwa (1889), and Yamagiwa (1890). The best accessible account of such cases is in Yamagiwa's (1890) paper. As causes of Jacksonian (cortical) epilepsy he gives:

(1) Tumors of various nature—Charcot (1883), Obernier, and others.

(2) Cerebral syphilis—Todd (1856), Charcot, and others.

(3) Softening, cyst-building, sclerotic centers—Knecht, Fütterer, Hammond, and others.

(4) Encephalitis, periencephalitis with adhesions, and meningitis—Huguenin, Bourneville, Mendel, Sakaki (1889), and others.

(5) Parasites, such as *Cysticercus cellulosæ*, reported by Griesinger (1872) and others; or *Echinococcus*, reported by Westphal (1873) and others; and *Distomum* (=*Paragonimus Westermanii*), reported in Japanese by Otani (1887) and Yamagiwa (1890). Since these and similar cases do not appear to have ever been published in English, it may be well to abstract one of them more or less in detail:

Otani's case was a twenty-six-year-old shoemaker, weakly since birth, but without any hereditary taint. In July, 1885, suffered from digestive troubles, with slight cough. Late in the spring—1886—he suddenly suffered from chills and fever, not malaria; had sharp pains in right thorax and severe attack of coughing. About a week later he noticed that his sputum was colored a dark-brown red. Ten days later felt much better, but bloody sputa continued; occasionally night-sweats, rise of temperature in the evening, and, in general, symptoms usually met with in consumptives. May, 1887, epileptic attacks began, one occurring nearly every month, but the intervals gradually increased in length.

September 9, 1887, admitted to the "inner station of the Kumamoto hospital." At that date temperature was 38.6° C. (101.5° F.); pulse rapid, weak, could hardly be counted; pupils contracted; "stands up and jumps as if he wanted to leave the bed." According to report, frequent epileptiform attacks had occurred since the evening previous. September 10, temperature, 37° C. (98.6° F.); pulse, 73; no attack, but patient very exhausted. September 12, again unconscious; temperature, 39° C. (102.2° F.); pulse, 100; more than ten attacks of cramps. September 15, semiconscious; temperature, 39° C. (102.2° F.); pulse, 120; keratitis of left eye; dirty-brown sputum, containing distome eggs. September 17, apathetic condition continues; temperature, 37° C. (98.6° F.); pulse, 80; a tightly adherent, hard tumor, painful to touch, size of goose egg, noticed in the fossa supraclavicularis. September 18, semiconsciousness continues; temperature, 38.8° C. (101.8° F.); pulse, 110. September 19, regained nearly normal consciousness. September 25, unconscious; temperature, 38.8° C. (101.8° F.); pulse, 106. September 26, death, with appearances of collapse.

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(*c*) *Liver infection.* Two cases of cirrhosis of the liver with ascites have been observed. *Paragonimus* eggs were found in the interstitial tissue.

(*d*) *Infection of other organs.* Cysts of *Paragonimus* eggs in the mesentery, great omentum, etc., have not produced any notable symptoms.

PATHOLOGY. (*a*) *Lung infection.* On the surface of the lungs or directly under the pleura cysts are formed which are usually smooth. The cyst wall is composed of newly-formed tissue with round-cell infiltration and of loops of the bloodvessels in the surrounding tissue. These cysts may contain one, two, or several specimens of *Paragonimus* with their eggs, or only the eggs may be found. Charcot's crystals are always present, and occasionally cholesterin crystals.

Taylor (1883) summarizes the postmortem appearance as follows:

Morbid anatomy. Four postmortems have been reported—two in Okayama in 1881, one in Tokyo in 1882, and again one in Okayama in 1883. Others may have been made and reported, but they have not come under my observation.

Externally the lung presents little or no change in appearance. The parasites are found in the smaller bronchi, and also burrowing in the lung tissue. Whether the parasites in the bronchi are found adhering to the mucous surface by their suckers is not stated. When the lung is cut across their burrows are laid open, and, though varying somewhat, these are generally about the size of a filbert. They frequently communicate with one another, and always with the smaller bronchi, sometimes by several openings. Some communicate directly with a bronchus, the lumen of this latter and the burrow forming one cavity, while the bronchus presents the appearance of having a sac-like dilatation on one side. Such cavities are probably formed by the exit from a burrow to the bronchus becoming enlarged, and, finally, the partition between adjacent burrows breaking down and forming one cavity. Each cavity is surrounded by a ring of irregular induration, extending much further into the parenchyma of the lung in some directions than in others. The adjacent bronchi are congested and more or less inflamed. So, also, the circumjacent lung tissue is congested. The cavities contain broken-down lung tissue, hematoidin, ova, and débris, or dead specimens of the parasite. In one case twenty distomata were found. The contents of these cavities mixed with the mucous secretion of the bronchi form the characteristic sputa. It is evident that the irritation of the parasite may at times so increase the bronchial secretion as to give rise to a large amount of expectoration; while exercise, especially when the patient is at his worst, aggravates the condition. Though the mortality

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from the disease is not high, there is no difficulty in realizing the condition of "physiological misery" that must necessarily accompany lungs in the condition described.

As all special treatment must be prophylactic, the most important question in connection with the disease is that of the mode of ingress of the parasite. It seems established that food is the medium. The Japanese consume large quantities of fresh-water snails and clams. Since the larvæ of various species of distoma are harbored by mollusks, it is probable that the parasite under consideration is in its larval state to be found in some of the mollusca consumed by the Japanese. The larvæ of other trematodes are found occupying one particular species as their host, and almost exclusively confined to that species. Such a species may be restricted to well-defined geographic limits, and thus the restriction of any parasitic disease, such as endemic hemoptysis, to certain regions would be satisfactorily explained by the corresponding restriction to the same regions of the conditions essential to the development of the parasite. What the intermediate host is remains to be determined, and when this is accomplished prophylaxis will take a definite and certain direction.

How the expectoration is produced has been pointed out, but the cause of the hemorrhage, which is always arterial, is not quite so clear. It is probable, however, that the parasite attaches itself to the mucous surface of the bronchi by its suckers, and when it releases its hold a drop of blood oozes out and appears as a pellet of blood in the expectoration [?], the larger hemorrhages being caused by the rupture of some of the capillaries or smaller arteries. Professor Baelz explains the bleeding by the passage of the larvæ from the circulation to the bronchi.

Hemorrhage, however, appears to be rather accidental than essential. In some cases it does not occur, and in these the expectoration is smoky or rusty, even when large in quantity. When small pellets of blood appear in the sputa from the first, they may and often do increase, small bleedings of half a drachm or a few drachms occurring frequently during a long period. But it is only in exceptional cases that the hemorrhages become frequent and large. Ova are not found in the pellets of blood or in the blood ejected during the course of a larger hemorrhage, but in the discolored expectoration, either with or without the bloody pellets.

A marked peculiarity of the disease is the irregular periodicity seen in so many cases. The occasional appearance of pellets of blood has substantially been accounted for, and the increased expectoration may be caused by accumulated contents of the cavities being poured out into the bronchi. The coughing thus produced keeps up expectoration until the cavities are comparatively empty, when the patient begins to convalesce. The fact that keeping quiet adds so much to the comfort of the patient at these times gives countenance to this hypothesis. But what becomes of the parasites themselves? Are they partially cast off in the abundant expectoration? One of my patients informed me that he had coughed up a worm. It was shown him under a low

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power by the doctors in a native hospital, and from his description it probably was a distoma. I cannot, however, be certain, as I did not myself see the specimen. It is probable that some of the parasites may be got rid of in this way; but how long does each individual distoma live in the lungs? and is an acute attack an indication that a re-enforcement of the parasites has secured entrance? These are questions which I cannot answer. Many cases are known to have been troubled with bloody expectoration for as many as ten years, and in one the condition had lasted for twenty. It is not at all likely that the individual life of a parasite will cover these extended periods, nor is it necessary that it should. Living under the same conditions renders the patient liable to again and again receive into his person this insidious intruder. Nor can it yet be said whether a change of locality to a place where the disease is not known is attended with permanent advantage. Persons thus afflicted seem to have derived at least temporary benefit after a change of locality. Whether those affected with endemic hemoptysis are more liable to other pulmonary diseases is not yet determined. The probabilities are that a lung thus affected would be more vulnerable than a normal lung.

. . . To what extent the disease occurs in Korea is not yet known. It may yet be found in some parts of China. Two of the patients seen at the mission dispensary in Hiogo were Chinese residing in Kobé, but whether they had contracted the disease in Kobé or in China could not be satisfactorily ascertained, but most probably while in Kobé.

(*b*) *Brain infection.* Cysts with the parasite and eggs or the eggs alone, causing emboli, may be found in the brain. The first case was reported by Otani (1887), the second by Miura (1889), and the third by Inoui and Yamagiwa in Japanese in 1889, and later (1890) by Yamagiwa in German.

The chief lesions found on postmortem examination were located in the brain and in the lungs.

BRAIN. *Gross appearance.* The surface of the hemispheres did not show any material change. Several adhesions between pia mater and the right hemisphere, notably in the occipitolateral region; here the gray substance was somewhat harder than usual. Upon sagittal sections of this portion there were seen dark-gray points, surrounded with a white border and thus sharply differentiated from the remaining tissue; line of demarcation between gray and white matter indistinct. These structures were found chiefly in the occipital and parietal lobes and in the median portion of the central convolution, and were confined almost entirely to the cortical layer.

Microscopic appearance. The enlarged and thickened bloodvessels of the sulci are considerably ramified; the branches which extend into the gray substance are in part open, in part obliterated. If an obliterated branch is followed into the deeper portion of the gray substance there is found an irregularly shaped focus, infiltrated peripherally with numerous round cells, and

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containing numerous brown bodies, the latter representing trematode eggs; in many cases the lumina of the smaller bloodvessels are filled with the same eggs. The surrounding proliferating and highly vascular connective tissue is infiltrated with round cells; also giant cells, occasionally containing eggs; further, also, in surrounding tissue are found numerous multinuclear Deiter's cells.

Yamagiwa then concluded that the primary location of the parasite which produced the eggs causing these egg emboli in the brain was in the lungs.

LUNGS. *Gross lesions.* On the upper left lobe were found here and there nodules of different size, with soft centers. The connective tissue capsule, which was highly pigmented and vascular, made them feel hard to the touch.

Microscopic appearance. The adult parasites were not found either in the lungs or in the brain, but the lung tubercles contained similar eggs and also giant cells.

It is interesting to note that the measurements of the eggs in the brain (40.3 by 24.5 μ to 64 by 40.6 μ) were on an average (52.1 by 32.5 μ) somewhat smaller than the actual (49 by 29.7 μ to 60.1 by 36 μ) or the average (55.9 by 33.4 μ) measurements of the eggs in the lungs. These variations Yamagiwa attributed to secondary conditions (direction of the section, compression, preservation, calcification, etc.).

Thus, to summarize, Yamagiwa shows: Disseminated circumscribed foci of trematode eggs, usually also with giant cells, in the cortical substance of the brain; localized in the occipital, parietal, and central lobes; surrounded by connective tissue new-formation and round-cell infiltration; thickening of the wall of the bloodvessels, especially of the adventitia, and obliteration of some of the branches; associated with lesions in the lungs containing eggs of the same species and giant cells.

(*c*) *Liver infection.* Cirrhosis of the liver resulting from emboli of eggs in the portal area (or perhaps coexistence of *Paragonimus* egg emboli with cirrhosis of the liver due to other causes).

(*d*) *Infection of other organs.* Cysts containing eggs of *Paragonimus* and fibrous nodules have been found in the mediastinum, diaphragm, mesentery, and walls of the intestines; and Otani is said to have found abscesses in the cervical and inguinal regions caused by trematodes. Eggs have also been found in the contents of the intestine. No lesions have been noticed in the spleen or the kidneys.

ABATTOIR INSPECTION. All lungs of hogs found to contain this worm should be "tanked" for fertilizer, in order to prevent dissemination of the eggs. There is, however, no danger of the

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direct transmission of the worm from hogs to man, since analogy with other members of the same family (Fasciolidæ) of parasites leads us to assume confidently that this species must pass through an invertebrate intermediate host (probably some mollusk) before it can infect another host. There is, therefore, not the slightest danger of infection from the eggs of the flukes connected with eating the pork from a hog which harbors the parasite in question, and inspectors should not, therefore, condemn the meat of such animals on the ground of the presence of the worms in the lungs.

In conclusion I should like to advance the fact of the presence of parasitic hemoptysis in this country as an argument in favor of the establishment of a Post-graduate School of Tropical Medicine. *Paragonimus Westermanii* is by no means the only exotic parasite which will be brought to this country, and our closer relations to certain tropical islands impose new duties upon our medical faculties in training men to practice in tropical climates. The discovery of this disease by American zoologists and veterinarians, who have thus been able to forewarn the physician to be on the lookout for the same malady in man, should also be recognized as a proof that zoology and human and comparative medicine are three very closely allied callings—a fact which, I regret to say, we in America are rather backward in acknowledging.

Epithelioma of the Mouth and Skin of a Catfish.

JOSEPH McFARLAND, M.D.

The specimen is a white catfish—*Ameiurus catus*, Linn.—which was brought to the Pathological Laboratory of the Medico-Chirurgical College by Dr. M. P. Dickeson, of Glen Riddle, Pa., to whom our thanks are due, both for the specimen as a valuable addition to our museum and for permission to describe it.

The fish measures thirteen inches in length. The left pectoral fin is of small size, evidently deformed as the result of injury. Except as further stated the animal is perfect.

What seems to be the primary tumor rises from the lower jaw,

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apparently from the mucous membrane of the mouth, and forms a mass about 1½ x 1 x ¾ inch, projects upward into the mouth and must have materially interfered with its closure. This tumor had an ulcerated surface and presented a distinctly lobulated and papillary appearance, the color being grayish-white.

Numerous nodules occur upon the head, six of them in a row along the edge of the upper jaw. Others were situated posteriorly and inferiorly to the left eye, over and behind the right eye, and upon the inferior surface of the neck. Most of the nodules appeared to be purely dermal.

There were no tumors upon the body, in the gills, or in the internal organs of the fish.

That the scattered nodules upon the skin of the head are secondary to that of the lower lip seems probable. The nodules along the upper lip suggest implantation.

The histologic study of the diseased tissue was made from fragments taken from the large node and from one of the growths upon the head. They show the neoplasm to be an epithelial growth—papillary epithelioma. It consists of a superficial fungous mass of branched papillæ composed largely of epithelial cells surrounding delicate fibrous and vascular outgrowths, and of a

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deeper infiltrated portion made up of ingrowths of squamous epithelium forming large, rounded epithelial masses.

No epithelial pearls appear in any of the sections. The epithelial masses are extensively infiltrated with leukocytes, and in some areas an apparent edema and leukocytic infiltration have disorganized the epithelial masses so as to form soft and conglomerate tissue pulp.

The soft fungous character of the tumors and the absence of epithelial pearls lead me to believe that the growth originates from the mucous membrane of the mouth, not from the skin.

So far as I have been able to determine, this is the first time epithelioma has been observed in the fish. *January* 10, 1901.

A Case of Hour-glass Contraction of the Stomach.

IDA E. RICHARDSON, M.D.,

AND

J. DUTTON STEELE, M.D.

Clinical Report by Dr. Richardson. The patient from whom the specimen was obtained was a white woman, thirty-eight years of age, and a native of the United States. Her grandfather died of tuberculosis of the lung. She herself was well and strong up to her fifteenth year; at that time she began to have symptoms of indigestion. There were periods of great pain directly after eating, which lasted for several weeks; this was followed by intervals of comparative comfort. Acid foods caused great distress, while sweet foods were well borne and appeared to give relief. For a time her diet consisted of bread, milk, and cream candy.

These symptoms lasted until the age of twenty-one years, when, under the effects of treatment, she greatly improved, until after six months the epigastric pain largely disappeared. About this time there was an attack of double pneumonia. In the course of a year, however, the pain reappeared and grew much more severe and at more frequent intervals. At the age of twenty-six years she had a profuse hemorrhage from her stomach. The blood was thick and black and came with vomiting. Some was passed from the rectum as well.

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She then went to Southern California for some months, and came home much improved, with relief from the epigastric pain. After her return she was fairly well for six months, when the distress in her stomach began again.

In 1897, at the age of thirty-four, the pain became almost unbearable. As before, it was aggravated by eating, and there was much distention by gas, with eructation.

While in the West Philadelphia Hospital for Women, in 1897, her stomach was washed out after a test meal; the examinations of the contents gave a total acidity of 40; lactic acid, erythrodextrin, and zymogen were present. The examination of the urine showed nothing of importance. The pain was so great that tuberculous peritonitis was suspected.

At the age of thirty-two years she discharged a large quantity of pus from her lung, and after that she had a cough, some pain in the chest, and profuse purulent expectoration.

In 1897 a physical examination made while she was in the hospital showed symptoms of consolidation at the left apex, and tubercle bacilli were found in the sputum.

She died in 1899 at the age of thirty-eight years.

Pathologic Report by Dr. Steele. The notes of the autopsy are as follows:

The abdominal cavity was free from fluid. There were dense adhesions between the left lobe of the liver, which was very prominent, with what appeared to be the pyloric end of the stomach and with the head of the pancreas and transverse colon. The transverse colon was somewhat M-shaped and crossed a little below the umbilicus. The lower portion of the stomach was covered by coils of small intestine. When these were raised it was seen that the stomach was a typical hour-glass one, with the point of contraction at the point of adhesion to the pancreas and liver. The constriction just admitted the little finger to the first joint, which slipped by the ring of contraction with difficulty. The wall of the stomach in the upper half of the constricted area was thick, and the mucous membrane shining and scarred, and suggested scar formation. The capacity of the pyloric and cardiac divisions was about equal.

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The pancreas was somewhat hard, but otherwise showed nothing of interest.

The hepatic flexure of the colon was adherent to the gall-bladder.

The spleen was tightly adherent to the stomach.

The whole upper lobe of the left lung was the seat of an advanced miliary tuberculosis with numerous areas of softening. The middle lobe of the right lung contained a large cavity, evidently tuberculous. The bone marrow of the sternum was splenified. The heart showed some fatty degeneration of the myocardium.

Microscopic examination of the lungs showed them to be the seat of tuberculosis. The head of the pancreas and the area of the liver, bowel, and stomach so closely adherent were examined with especial reference to malignant disease. The adhesions were found to be fibrous in character and with no suggestion of any malignant process.

Examination of the stomach wall in the upper portion of the constriction showed that it consisted of a thin and distorted layer of epithelium much infiltrated by round cells, a rather firm layer

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of fibrous tissue, the usual endothelial covering, and a very thin and distorted layer of muscle tissue. In places this last was entirely absent.

A piece of the stomach wall from near the pylorus showed some degeneration of the epithelium manifesting itself as granulation and vacuolization of the cells, and an infiltration of the epithelial layer with a considerable number of round cells.

The so-called hour-glass stomach is a somewhat rare condition. There have been four specimens of the condition presented before this Society. The first was shown in 1860 by Dr. Livezey (vol. ii, page 30). The constriction was apparently a result of contraction of a scar following an ulcer.

The second was reported by Dr. D. J. Milton Miller (vol. xvii, page 61). The stomach was constricted about its middle by secondary involvement of the stomach wall by a cancer rising in the head of the pancreas.

The third case was reported by Dr. A. E. Taylor (N. S., vol. i, page 183). The constriction was fibrous and its etiology uncertain.

The fourth case was one reported by myself at the first meeting of the present year. The constriction was of rather large caliber, and was apparently due to the healing of an ulcer.

In none of these cases was the condition diagnosed during life.

The constriction may be congenital, but it arises most frequently from the contraction of a scar, due to healing of one or more peptic ulcers; less often it may be produced by peritoneal adhesions or malignant disease. Riegel gives as the most usual cause the healing of ulcers that have involved both surfaces of the stomach and extend around the lesser curvature. The healing of several smaller ulcers lying near each other on the anterior and posterior wall may produce the same result.

The amount of constriction, of course, varies from the slight distortion of the shape of the stomach to the division of the viscus into two parts, connected by an opening that in some cases is extremely narrow. In the case here reported the communication barely admitted the tip of the little finger. In a case reported by Sache (*Virchow's Archiv.*, vol. cxxxiv) the opening measured about three-quarters of a centimeter in diameter.

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As a rule, the two portions are not found to be equal in capacity at the autopsy, whatever they may have been originally. The cardiac segment is usually ectatic. This is caused by increased effort on the part of the stomach to force its contents through the narrow opening and to the consequent accumulation of food.

The symptoms are very indefinite and the condition is often not suspected until the autopsy. They are usually those of pyloric stenosis in the milder cases. In others the only evidences of the condition are those of the disease producing it.

The most characteristic physical signs are as follows:

First. A clear succussion splash over one portion of the stomach area, after the stomach has apparently been emptied by lavage.

Second. When the stomach tube has been passed and the washings are coming clear, there may be a sudden flow of gastric contents, especially when the stomach is massaged in the neighborhood of the pylorus. This sign is not absolutely trustworthy, as it sometimes occurs in cases of high-grade dilatation without constriction.

Third. Inflation with air through the tube shows the characteristic hour-glass shape of the organ. This, of course, is conclusive.

The microscopic examination in the case here reported, together with the macroscopic appearances, would indicate that the constriction was produced by the healing of an ulcer upon the lesser curvature about midway between the cardiac end and the pylorus, and involving the anterior and posterior walls. The history points rather definitely to the fact that the patient had suffered with gastric ulcer some twelve years previous to her death. The attack of hematemesis at that time probably marked the acute stage of the ulcer, which was followed by slow healing, and the beginning of the constriction. From that time onward the symptoms were those of dilatation of the stomach. The severe pain that led to suspicion of peritonitis may have been due to the extensive adhesions between the stomach, liver, and pancreas.

January 10, 1901.

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